A Case of Penetrating Craniomaxillofacial Injury in the Time of COVID-19

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ABSTRACT

Objective: To describe a case of a craniomaxillofacial penetrating injury focusing on the importance of a multidisciplinary approach with insights into the surgical planning for successful removal of the foreign body during the pandemic.

Methods:

Design: Case Report
Setting: Tertiary Government Training Hospital
Patient: One

Results: A 15-year-old boy presented with a work-related puncture wound in the right nasomaxillary area with accompanying soft-tissue swelling. Physical examination of his face showed no external foreign body. Craniofacial computed tomography scans revealed a rod-shaped opaque foreign body about 12 cm in length and 9 mm in diameter lodged in the right maxillary sinus extending to the right temporal lobe. The otolaryngology-head and neck surgeon and neurosurgeon planned the crucial extraction of the foreign body, but the requirement for a negative RT-PCR, blood products, and additional imaging delayed this emergent operation. The foreign body was eventually removed via combined trans-antral approach and right frontotemporal craniotomy, zygotomy, and craniectomy around the foreign body in the temporal floor with duraplasty and cranioplasty.

Conclusion: Successful treatment of penetrating craniomaxillofacial injuries involves diligent clinical assessment, radiologic diagnosis and a well-planned multidisciplinary surgical approach. Delays in treatment may be beneficial if they allow precise location of the foreign body and thorough evaluation of involved structures. Safeguarding the healthcare workers during the pandemic was as important as ensuring a successful and safe surgery for the patient.

Keywords: *foreign body; metal impalement, temporal lobe; maxillary sinus; internal maxillary artery; middle cerebral artery; subtemporal fossa, infratemporal fossa*

Foreign body penetrations are relatively rare in the craniomaxillofacial area and may occur in all stages of life.[1] Various foreign bodies penetrating the skull base have been reported including wood, metallic fragments and toothbrushes.[2] Major neurological deficits may not manifest immediately but serious events may occur after several days, months or years, even if patients were initially asymptomatic.[3,4] A computed tomography (CT) scan of the head facilitates early extraction by localizing the foreign body and demonstrating bone fragments and other lesions.[5] However, during the COVID-19 pandemic, emergent surgical cases were a challenge for both healthcare workers and patients. While indications for surgical procedures did not change,

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surgical and hospital protocols were modified to reduce exposure and transmission of COVID-19.[6] We report one such case.

CASE REPORT

A 15-year-old fisherman was starting his boat engine when a metal rod was propelled through his face after he pulled the motor cord. A puncture wound in the right nasomaxillary area was noted with accompanying minimal epistaxis that resolved spontaneously. He also experienced brief loss of consciousness for a few seconds witnessed by another fisherman. He was already conscious when brought to the hospital.

Physical examination revealed a 10 mm puncture wound in the right nasomaxillary area with accompanying soft-tissue swelling. *(Figure 1A)* There was no evidence of any foreign body on his face. He had trismus with an inter-incisal distance of only 19 mm. *(Figure 1B)* He had a Glasgow coma score of 15 and with all cranial nerves intact including the right trigeminal nerve.

Contrast - enhanced craniofacial CT scans revealed a rod-shaped opaque foreign body measuring about 12 cm in length and 9 mm in diameter in the right maxillary sinus extending to the right temporal area. The anterior and posterolateral maxillary sinus walls were penetrated and fractured and there was hemosinus. At the skull base, the foreign body traversed the right infratemporal fossa penetrating the right temporal lobe. *(Figure 2A, B)* The pterygoid plates and pterygopalatine fossa were intact and distant to the foreign body which also spared the right internal maxillary artery. *(Figure 2C)* Nasal endoscopy revealed bloody streaks but no active bleeding in the right nasopharyngeal area close to the torus tubarius, with no foreign body visible through the nasal cavity. *(Figure 3A)*

Craniofacial CT angiography demonstrated intact intracranial vessels, particularly the right middle cerebral artery where the foreign body was located approximately 2.5 cm inferior and away from this vessel. *(Figure 3B)* Three-dimensional (3D) reconstruction of the craniofacial CT scan approximated the length traversed by the foreign body per area: 2.2 cm in the maxillary sinus, 1.4 cm in the subtemporal fossa and 8.4 cm intracranially. *(Figure 4A)* The trajectory of the foreign body measured 13º in the axial plane and 15º in the sagittal plane with the base at the point of entry. *(Figure 4B, C)*

Tetanus toxoid, dexamethasone, levetiracetam and triple therapy antibiotics (ceftriaxone, metronidazole and oxacillin) were administered while the multidisciplinary team planned emergent foreign body removal via combined transantral approach and right frontotemporal craniotomy, zygotomy, and craniectomy around the foreign body in the temporal floor, with duraplasty and cranioplasty. However, surgery was delayed until the 14th day of admission due to pandemic protocols requiring a negative RT-PCR swab as well as additional vascular imaging and blood products needed for intraoperative use. Because an airborne infection isolation room or negative-pressure operating room were not available, the aerosol-generating procedure was performed in a regular

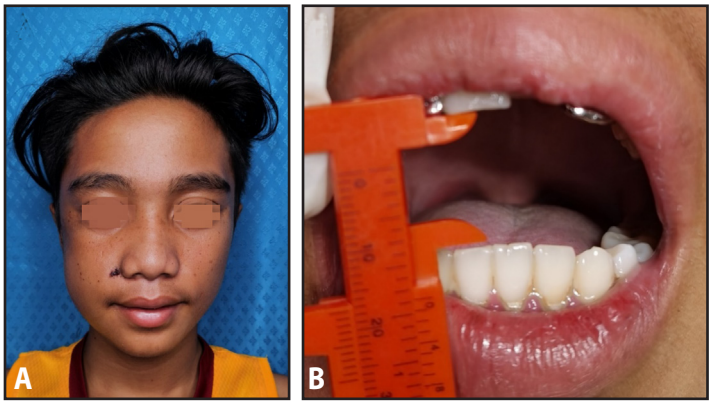

Figure 1. Pre-operative photos of patient showing: **A.** 10mm puncture wound on the right nasomaxillary area and accompanying soft tissue swelling; and **B.** inter-incisal distance of 19mm. Photos published with permission.

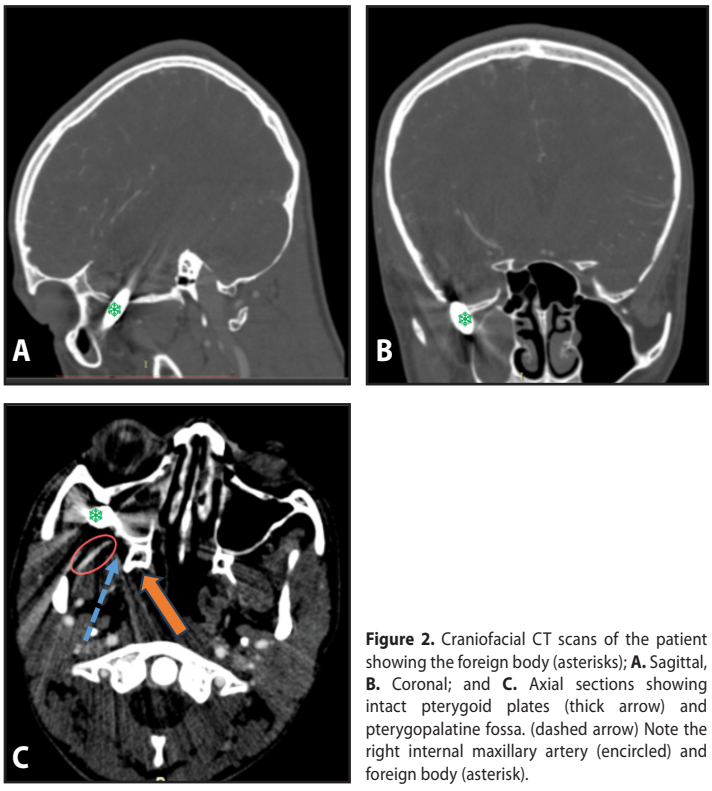

Figure 2. Craniofacial CT scans of the patient showing the foreign body (asterisks); **A.** Sagittal, **B.** Coronal; and **C.** Axial sections showing intact pterygoid plates (thick arrow) and pterygopalatine fossa. (dashed arrow) Note the right internal maxillary artery (encircled) and foreign body (asterisk).

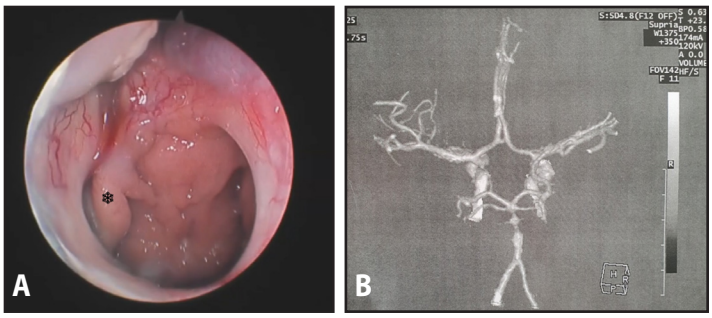

Figure 3A. Right nasal endoscopic view revealing blood streaks in the nasopharyngeal area close to the torus tubarius (asterisk); and ıCT angiogram showing intact intracranial vessels

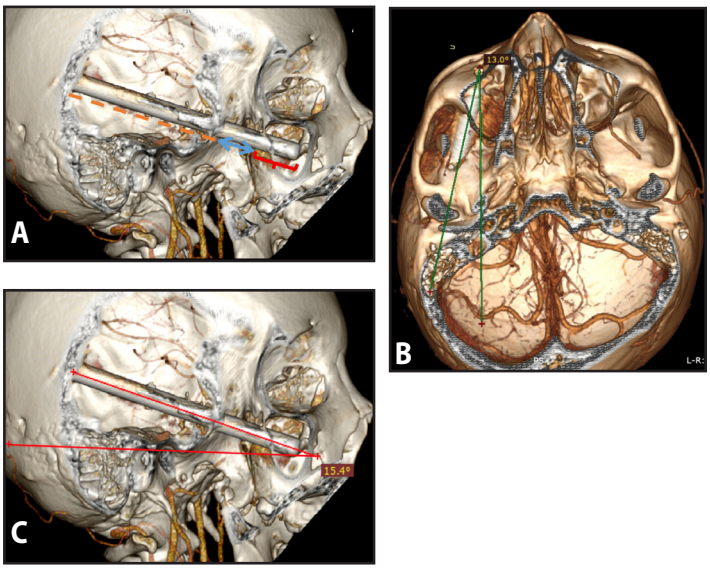

Figure 4. 3D reconstruction of CT scan showing the foreign body and related structures: **A.** 2.2 cm in the maxillary sinus (bracket), 1.4 cm in the subtemporal fossa (double-headed arrow), and 8.4 cm intracranially (dashed line); **B.** axial; and **C.** sagittal windows revealing the trajectory of the foreign body which measured 13º and 15º, respectively.

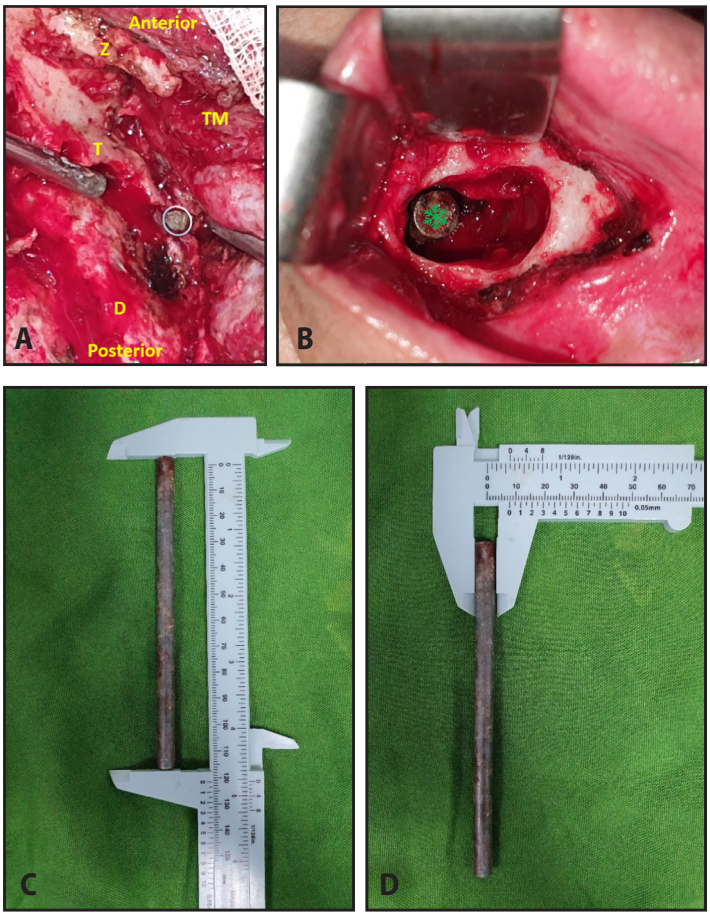

Figure 5. A. Intraoperative photo showing cranial end of the metal rod (encircled): Z, zygomatic bone; T, temporal bone; TM, temporalis muscle; D, dura; **B.** caudal end of metal rod (asterisk) at the maxillary antrum; **C.** post extraction metal rod 12 cm in length; and **D.** 0.5 cm in diameter

operating suite with a portable air purifier set at 17 air changes per hour (ACH) and the surgical team donned level 4 personal protective equipment (PPE).[7]

After asepsis and antisepsis of the head, face and neck (for possible clipping and/or ligation of the internal maxillary artery and/or external carotid artery) the neurosurgery service (NSS) performed a frontotemporal craniotomy utilizing a curvilinear incision, temporalis muscle dissection, bone flap development and burr hole placement. The anterior third of the right zygomatic arch was removed and drilled to access the temporalis muscle. Zygomatic arch removal also provided access to the internal maxillary artery in case of injury on extraction of the foreign body. The distal tip of the metal rod was carefully located and craniectomy along the temporal floor freed the foreign body. The otolaryngology-head and neck surgeons (ORL-HNS) exposed the anterior maxillary sinus wall fracture through a gingivobuccal approach in the right maxillary canine fossa. The foreign body was carefully located and synchronously delivered by the ORL-HNS who extracted the foreign body transantrally under endoscopic visualization while the NSS guided the metal rod caudally through the craniotomy. The foreign body measured 12 cm in length and 0.5 cm in diameter with no sharp edges. *(Figure 5)* Post extraction, the brain parenchyma, infratemporal and subtemporal fossa, and posterior maxillary sinus were inspected. There was no bleeding, as granulation tissues had formed throughout the course of the foreign body, and vascular clipping or ligation were averted. The gingivobuccal sulcus mucosa was apposed using continuous absorbable sutures. Closure, duraplasty with temporal bone periosteum and osteoplastic flap cranioplasty were uneventful. There were no immediate post-operative complications observed.

Post-operatively, the patient was fully conscious and oriented, with no seizures or neurological deficits. Vancomycin, meropenem and levetiracetam were administered. A repeat cranial CT scan confirmed complete removal of the foreign body with minimal residual parenchymal edema and vasogenic edema in the right temporoparietal lobe. There was gradual but significant improvement of trismus with an inter-incisal distance of 32 mm prior to discharge. *(Figure 6)* The patient was well on follow up at 31 days post-operatively.

DISCUSSION

Penetrating foreign bodies are potentially life-threatening depending on the location and extent of penetration especially in the craniomaxillofacial region. Impalement injuries of the head and neck area require precise detection of the foreign body, its anatomical position, and the affected surrounding structures to facilitate successful removal. Thus, it is essential for surgeons of the head and neck area including ophthalmologists, otorhinolaryngologists, craniomaxillofacial surgeons and neurosurgeons to be familiar with the management and care of these injuries.[1,2]

Foreign bodies should generally be removed to avoid acute or chronic infection, but first responders should leave foreign bodies in

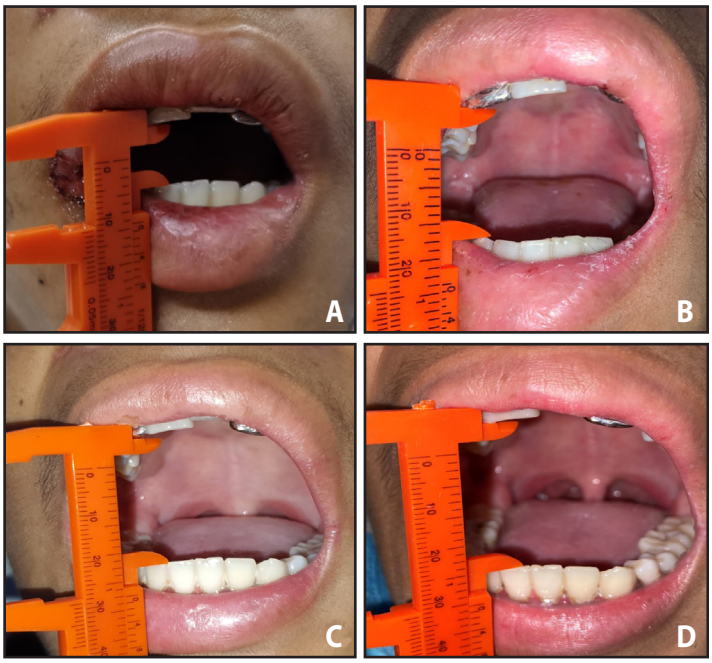

Figure 6. Serial post operative inter-incisal distance: **A.** Day 1, 11 mm; **B.** Day 10, 24 mm; **C.** Day 25, 27mm; and **D.** Day 31, 32 mm

place, as they might act as a tamponade preventing severe bleeding.[8] The risk of collateral damage has to be weighed against the potential benefits when contemplating formal surgical removal of a foreign body.[9] Full physical and radiological examinations may delay extraction but are necessary because premature surgery can lead to fatal results.[2]

The involvement of the maxillary sinus, infratemporal fossa and the brain in this case warranted a multidisciplinary team of NSS and ORL-HNS. The team decided to remove the foreign body trans-antrally instead of cranially to reduce the risk of vascular injury involving the right middle cerebral artery since the foreign body was already located inferiorly to it. It was also agreed to wait for a negative RT-PCR result since procedures done in the oral cavity and sinuses were considered aerosol-generating even if this was an emergent case.[10] Further delays in this case were due to the need for additional vascular imaging and securing of blood products.

The neurosurgery service opted for a craniotomy of the temporoparietal area to access the temporal cortex for possible hemostasis if bleeding occurred or if there would be a need to repair the affected area and close dura. It also provided access to the infratemporal fossa where part of the metal rod was visualized and acted as a port to guide extraction of the metal rod. On our end, a gingivobuccal incision was created to locate and widen the perforation on the anterior maxillary wall for a trans-antral extraction of the metal rod. Preparations were also made to open the posterior maxillary area if there would be a need to expose the pterygopalatine fossa and ligate the internal maxillary artery.

Extraction was done synchronously by both services. As the neurosurgeons guided the metal rod toward the maxillary antrum from their access point at the infratemporal fossa, the ENT-HNS surgeons pulled it out trans-antrally while visualizing the procedure endoscopically, ensuring that the foreign body was pulled out slowly and in a linear fashion to avoid injury to other structures. On post extraction surveillance, granulation tissues were observed along the track which apparently walled off the foreign body, sealing the structures surrounding it.

Postoperatively, the patient did not exhibit any neurologic deficit but had persistent trismus. Since the metal rod had impaled the right maxillary sinus extending to the right temporal lobe, infratemporal fossa involvement may explain the trismus as both the medial and lateral pterygoid muscles that respectively elevate and depress the mandible were in the area. Following foreign body removal, the trismus gradually resolved over one month of rehabilitation utilizing mouth-opening exercises.

In conclusion, successful treatment of penetrating craniomaxillofacial injuries involves diligent clinical assessment, radiologic diagnosis and a well-planned multidisciplinary surgical approach. Delays in treatment may be beneficial if they allow precise location of the foreign body and thorough evaluation of involved structures. Safeguarding the healthcare workers during the pandemic was as important as ensuring a successful and safe surgery for the patient.

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